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PROGRESS REPORT

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Principal Investigator: Harry D. Olree, Ed.D.

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This report covers Experiment IV of four experiments to be conducted during a 24-month period beginning January 1, 1974. In Experiment I three groups of males trained twenty minutes a day, three days a week for ten weeks. One group trained on the Super Mini-Gym, a second group trained on the Universal Gym, and a third performed calisthenics. Cardiopulmonary gains were negligible but all training groups exhibited good gains in strength.

In Experiment II three groups of males trained twenty minutes a day, three days a week for ten weeks. One group trained on a floor model Super Mini-Gym, a second group trained on a Super Mini-Gym bicycle at low resistance, and a third group trained on a Super Mini-Gym bicycle at high resistance. The floor model produced a moderate increase in strength and a very slight increase in cardiopulmonary fitness. The bicycle produced negligible gains in strength and a very slight increase in cardiopulmonary fitness. The bicycle was found to have mechanical faults which make it unsuitable as a piece of exercise equipment.

In Experiment III three groups of males trained twenty minutes a day, three days a week for ten weeks on a Monarch stationary bicycle. One group trained in an upright position at a pulse rate of 160 beats per minute, a second group trained in a supine position at the same pulse rate and a third trained in a supine position at an intensity equal to the group training in an upright posture. Negligible increases in strength were produced. All training groups made moderate increases in cardiopulmonary fitness.

In Experiment IV three groups of females trained twenty minutes a day, three days a week for ten weeks at a pulse rate of 85 percent of the maximum attained during a treadmill test. One group trained on a Monarch stationary bicycle, a second group trained by running on an outdoor track, and a third group trained by walking on a treadmill. All training groups had some gains in strength and physical work capacity. The running group had lesser gains in both areas.

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Experiment IV: Comparison of Bicycling, Running, and Treadmill Walking for Developing Physical Work Capacity

Harry Olree, Bob Corbin, David Elliott, Carroll Smith
Harding College, Searcy, Arkansas

I. Introduction

A number of physiological changes, which are in general referred to as deconditioning, result from living in the environment of space. Two possible ways to minimize the effects of deconditioning in space are to achieve a very high level of conditioning immediately prior to flight and provide a regimen in the capsule which will conserve pre-flight physical fitness and maintain a moderate degree of fitness. This laboratory has been investigating methods and equipment to determine how these two goals might be efficiently attained.

It was determined in this laboratory that running and riding a bicycle ergometer at comparable heart rates produced similar gains in physical fitness variables. It was found that subjects who exercised at a 180 heart rate made greater gains in physical fitness than did those exercising at a 140 or 160 heart rate. When the length of the workout was varied, subjects exercising sixty minutes per day made greater gains than those exercising twenty or forty minutes per day. Greater gains on specified components of physical fitness also resulted when subjects exercised twelve times per week as compared to those who exercised three or six times a week. Subjects who discontinued training slowly deconditioned, but a moderate level of fitness could be maintained by exercising at a pulse rate of 160 beats per minute for twenty-minute periods three times a week. Subjects who "overtrained" twice daily to near exhaustion increased in fitness.

Exercise programs involving four pieces of equipment, the Exer-Genie Exerciser, the Collins Pedal Mode Ergometer, the Universal Gym and the Super Mini-Gym, have been investigated. It was found that neither six- nor twelve-minute training periods each day involving isometric and isotonic exercises with an Exer-Genie resulted in significant increases in selected physical fitness variables. Training in a supine position on the Exer-Genie at a 160 pulse rate for twenty minutes per day showed no significant change in fitness. Three training programs involving the Collins Ergometer have been examined. One group of subjects exercised for twelve minutes per day with the heart rate programmed to increase during the training period. Another group exercised for ten minutes a day 85 percent of their maximum heart rate while a third group exercised at a 160 heart rate for ten minutes a day. Each of these groups showed moderate increases in fitness.

Moderate gains in physical fitness were produced in three exercise groups of men 30-45 years old who were initially in poor to fair condition. One group exercised for ten minutes a day, three times a week on a bicycle ergometer at 85 percent maximum pulse rate. Another group exercised for ten minutes a day, five times a week on a bicycle ergometer at 85 percent maximum pulse rate. The third group exercised for ten minutes a day, three times a week on the bicycle ergometer at 85 percent maximum pulse rate and two times a week on an Exer-Genie circuit. These three exercise groups made comparable gains in fitness.

A combination of exercises has been investigated. One group of subjects' exercised for twenty minutes a day, three days a week, on a foot-mode ergometer at 85 percent maximum pulse rate and twenty minutes a day, two days a week, on a hand-mode ergometer at 70 percent maximum pulse rate. A second group had the same schedule but worked on the hand-mode ergometer at 85 percent

maximum pulse rate. The third group exercised for twenty minutes a day, three days a week, on a foot-mode ergometer at 85 percent maximum pulse rate and two days a week on a seven-station Exer-Genie circuit. These groups made moderate gains in strength and cardiopulmonary fitness.

Another combination included endurance and strength training in the same workout. The three exercise groups worked fifteen minutes a day, three days a week on a foot-mode ergometer at 85 percent of their maximum heart rate. Each group immediately followed this with an additional fifteen minutes of exercise. One group completed two circuits on a seven-station Exer-Genie circuit at each exercise session. One group exercised on a hand-mode ergometer. The third group completed two circuits on a seven-station Super Mini-Gym circuit during each exercise session. All groups made moderate cardiopulmonary gains but only the Exer-Genie and the Mini-Gym were effective in increasing strength.

An experiment was performed to compare exercise on equipment designed solely to produce strength, exercise of the lower torso only to produce cardiopulmonary fitness and exercise of the upper torso only so as to produce cardiopulmonary fitness. One group worked thirty minutes a day, three days a week, on a Universal Gym. Another group worked thirty minutes a day, three days a week, on a foot-mode ergometer at 85 percent of their maximum pulse rate. A third group worked thirty minutes a day, three days a week, on a hand-mode ergometer at 85 percent of their maximum pulse rate. The group exercising on the Universal Gym gained in arm and shoulder girdle strength. The subjects exercising on the foot-mode ergometer gained in leg strength and all groups made moderate gains in cardiorespiratory fitness.

The effect of stress on highly trained subjects has been investigated by confining one group in bed for five days and depriving a second group

of sleep for fifty hours. The pre-stress training, which lasted twelve weeks, consisted of a three-mile run three days a week and working on a Universal Gym for thirty minutes a day, twice a week. Good increases in strength and cardiopulmonary fitness were obtained. Both stresses caused negligible decreases in strength variables but drastic decreases in cardiopulmonary fitness. Two weeks post-stress the subjects had recovered about half of the conditioning they lost.

In an experiment comparing the Super Mini-Gym, the Universal Gym and calisthenics, subjects trained twenty minutes a day three days a week. The training programs produced comparable results, negligible increases in cardiopulmonary fitness and good gains in strength.

The Super Mini-Gym bicycle was evaluated and compared with the floor model. The bicycle was found to have serious mechanical faults. One group on the bicycle trained at high resistance while the second group on the bicycle trained at a low resistance. Pedal speed was adjusted so that pulse rates were comparable. Slight gains in strength and cardiopulmonary fitness resulted. However, the floor model produced good gains in strength.

The effects of bodily posture were investigated by training one group in an upright position at a pulse rate of 160 beats per minute, a second group in a supine position at the same pulse rate and a third trained in a supine position at a work intensity equal to the group training in an upright posture. All training groups made moderate increases in cardiopulmonary fitness and slight increases in strength.

II. Purpose

The purpose of this experiment was to determine the relative effectiveness of bicycling, running and treadmill walking for increasing physical work capacity in college-age females.

III. Methods

The subjects in this experiment were twenty college-age female volunteers whose physical work capacity was average for the Harding College coed. Base lines were determined on specified variables by administering the following: (a) a medical examination, (b) anthropometrical measurements, (c) skinfold measurements, (d) body composition measurements, (e) three cable tensiometer strength measurements, (f) three Cybex dynamometer strength measurements, and (g) a treadmill test.

The medical examination included a six-lead ECG, a vital capacity test (1), a maximum breathing capacity test (1), and serum and urine analyses for glucose. The following anthropometrical measurements were taken: neck, bicep, forearm, waist, thigh and calf. The following skinfold measurements (2) were taken: axilla, tricep, subscapular, abdominal, suprailiac, and thigh. A sum of the values for these six sites was calculated. Body composition measurements (3) were determined by hydrostatic weighing with the subject sitting. Cable tensiometer measurements (4) of shoulder flexion, hip flexion and ankle plantar flexion were taken. Using a Cybex dynamometer, measurements of both flexion and extension of the elbow, knee and hip were taken (5).

Each subject was given a treadmill test (6) in which the speed of the belt was constant at 90 meters per minute with an increment in grade of one percent per minute. Pulse rate and blood pressure (systolic and diastolic) were measured manually on alternate minutes until a pulse rate of 160 beats per minute was attained. Thereafter, the pulse and pressure were monitored each minute. The test was terminated when the subject reached a near maximum pulse rate. Expired gas samples were collected at a 180 pulse rate and the last minute to determine several measurements of cardiorespiratory fitness. Pulse and pressure were monitored post-test for three minutes with the subject sitting.

By using a table of random numbers the twenty subjects were divided into four groups of five each. Subjects in Groups A, B, and C trained and Group D served as a control, engaging in their normal daily activities without any specified training program.

The training lasted ten weeks and during this time the groups exercised for twenty-minute periods three times per week. All groups trained at 85 percent of the maximum pulse rate attained during the treadmill test. Pulse rates were monitored manually every two to five minutes during workouts. Group A trained on a Monarch stationary bicycle. Group B trained by jogging on a quarter-mile track. Group C walked on a treadmill at 3.5 miles per hour with the elevation varied so as to produce the required heart rate.

The effects of the training program were evaluated at the end of the experiment by readministering the initial baseline tests.

The data were analyzed by analysis of variance and Duncan's Multiple Range tests on selected contrasts where indicated. The following model was used for the analysis of variance: $Y_{ijkl} = U + A_i + B_j(i) + C_k + E_l(ijk)$, where A represents the groups and is considered fixed, B represents the subjects and is considered random, and C represents the tests and is considered fixed.

In the Anova Table the number of observations (N) is forty for all variables. The number of groups (n) is four, the number of subjects per group (p) is five and the number of tests (q) is two for all variables.

TABLE I
ANOVA TABLE

Source	Df	E(ms)	F
Total	N-1		
(A) Groups	n-1	(1) $\sigma_E^2 + q \sigma_{B(A)}^2 + pq \sigma_A^2$	1/2
B(A) Subjects in Groups	n(p-1)	(2) $\sigma_E^2 + q \sigma_{B(A)}^2$	
C Tests	(q-1)	(3) $\sigma_E^2 + \sigma_{[B(A)C]}^2 + np \sigma_C^2$	3/5
AC Groups, Tests Interaction	(n-1)(q-1)	(4) $\sigma_E^2 + \sigma_{[B(A)]C}^2 p \sigma_{AC}^2$	4/5
[B(A)]C Subjects in Groups, Tests Interaction	n(p-1)(q-1)	(5) $\sigma_E^2 + \sigma_{[B(A)]C}^2$	

IV. Results and Discussion

The average age, height, and weight for each group prior to the beginning of the training are given in Table II.

TABLE II

MEAN AGE, HEIGHT, AND WEIGHT OF SUBJECTS

GROUP	AGE (yr)	HEIGHT (cm)	WEIGHT (kg)
A - Bicycle	20.8	170.6	62.7
B - Running	21.2	169.4	63.1
C - Treadmill	20.8	168.6	66.5
D - Control	21.0	166.4	61.3
ALL	20.9	168.8	63.4

The significant changes that were found for all variables that were measured pre- and post-training are listed in Table III. The significance level is indicated ($p < 0.1$, 0.05, 0.01 or 0.001). A significant decrease is indicated by a minus sign in front of the significance level and a significant increase is indicated by the lack of a sign.

Table IV contains the mean pre- and post-training values of all the variables that were measured.

Groups A and B had significant increases in girth measurements for both thighs and both calves, whereas, Group C, walking on the treadmill did not show any change (Table III).

TABLE III
SIGNIFICANCE LEVELS OF CHANGES IN VARIABLES MEASURED
PRE- AND POST-TRAINING

VARIABLE	GROUP			
	A Bicycle	B Running	C Treadmill	D Control
<u>ANTHROPOMETRIC MEASUREMENTS</u>				
Neck				
Right Bicep				
Left Bicep				
Right Forearm				
Left Forearm				.05
Waist	.05			
Right Thigh	.1	.01		
Left Thigh	.01	.05		
Right Calf	.05	.05		
Left Calf	.05	.01		
<u>SKINFOLD MEASUREMENTS</u>				
Axilla				.1
Tricep				
Subscapular				
Abdominal				
Suprailiac				
Thigh	.1			
Sum of Sites				
<u>STRENGTH MEASUREMENTS</u>				
Shoulder Flexion, Cable	.05	.05	.05	
Hip Flexion, Cable		.05		
Ankle Plantar Flexion, Cable	.05			.1

TABLE III...SIGNIFICANCE LEVELS OF CHANGES IN VARIABLES MEASURED PRE- AND POST-
TRAINING CONTINUED

VARIABLE	GROUP			
	A Bicycle	B Running	C Treadmill	D Control
<u>Strength Measurements Continued</u>				
Strength Quotient	.05		.05	
T Score	.05		.1	
Elbow Flexion, Cybex				
Elbow Extension, Cybex				
Knee Flexion, Cybex		.05		.1
Knee Extension, Cybex	.05			
Hip Flexion, Cybex			-.05	
Hip Extension, Cybex	.05			
<u>PHYSIOLOGICAL VARIABLES</u>				
One Second Vital Capacity			-.05	
Maximum Vital Capacity				
Maximum Breathing Capacity				.01
Respiratory Rate at MBC				
Tidal Volume at MEC				.05
Body Composition				
Weight			-.001	-.01
<u>TREADMILL TEST VARIABLES</u>				
Time on Treadmill to 180 P.R.	.001	.01	.001	
Time on Treadmill to Max. P.R.	.001	.001	.001	
Systolic Blood Pressure at Rest				-.05
Systolic Blood Pressure at 180 P.R.				
Systolic Blood Pressure at Max. P.R.				
Systolic Blood Pressure at 3rd Minute Recovery				-.1

TABLE III...SIGNIFICANCE LEVELS OF CHANGES IN VARIABLES MEASURED PRE- AND POST-
TRAINING CONTINUED

VARIABLE	GROUP			
	A Bicycle	B Running	C Treadmill	D Control
Diastolic Blood Pressure at Rest				
Diastolic Blood Pressure at 180 P.R.			.01	
Diastolic Blood Pressure at Max. P.R.			.05	
Diastolic Blood Pressure at 3rd Minute Recovery				
Pulse Rate at Rest				
Pulse Rate at 180 P.R.				
Pulse Rate at Max. P.R.	.05	.1	.05	
Pulse Rate at 3rd Minute Recovery	.05	.05	.05	
\dot{V}_E BTPS at 180 P.R.	.05			
\dot{V}_E BTPS at Max. P.R.	.05	-.05		.1
\dot{V}_E STPD at 180 P.R.	.05			
\dot{V}_E STPD at Max. P.R.	.05	-.05		.1
Respiratory Rate at 180 P.R.	.1			
Respiratory Rate at Max. P.R.		-.05		
Tidal Volume at 180 P.R.			.05	
Tidal Volume at Max. P.R.				
\dot{V}_{O_2} at 180 P.R.	.05		.05	
\dot{V}_{O_2} at Max. P.R.			.1	
\dot{V}_{O_2} /Pulse at 180 P.R.	.05		.01	
\dot{V}_{O_2} /Pulse at Max. P.R.			.05	
\dot{V}_{O_2} /kgbw·min at 180 P.R.	.05		.05	
\dot{V}_{O_2} /kgbw·min at Max. P.R.			.05	
\dot{V}_E/\dot{V}_{O_2} at 180 P.R.				
\dot{V}_E/\dot{V}_{O_2} at Max. P.R.	.1	-.05	-.1	

Significant changes in strength did not correlate closely with anthropometric changes (Table III). It is apparent that all training groups did increase in strength. The two derived variables, Strength Quotient and T Score, indicate overall strength increases. The T Score is a percentile of the norm. Groups A and C had significant increases in overall strength as indicated by these two variables.

There was no significant change in body composition as indicated by hydrostatic weighing and the sum of skinfold measurements taken at six sites.

The variables in Table III that are most indicative of physical work capacity are Time on the Treadmill and $\dot{V}_{O_2}/kgbw \cdot min$. All training groups had highly significant increases in Time on Treadmill to 180 Pulse Rate and to Maximum Pulse Rate. Groups A and C had significant increases in $\dot{V}_{O_2}/kgbw \cdot min$. to 180 Pulse Rate, whereas, only Group C had a significant increase in $\dot{V}_{O_2}/kgbw \cdot min$. at Maximum Pulse Rate. The post-training values for $\dot{V}_{O_2}/kgbw \cdot min$. to a 180 Pulse Rate for Groups A, B, and C represent increases of 14 percent, 4 percent, and 15 percent respectively. In a similar experiment conducted in 1967 using college age males, increases of 15 percent, 24 percent, and 7 percent were found in oxygen uptake per kilogram of body weight measured at a 180 Pulse Rate.

It is interesting that the running group, Group B, made no significant gains in $\dot{V}_{O_2}/kgbw \cdot min$. at either 180 Pulse Rate or Maximum Pulse Rate. It is more difficult to closely monitor the pulse rate by manual methods of subjects that are running. In addition, the subject must interrupt exercise for ten seconds each time the rate is counted. It is possible that this could affect the results of the training.

V. Conclusions

1. Pedalling a stationary bicycle, running on an outdoor track and walking on a treadmill produced increases in strength variables. Pedalling a bicycle and walking a treadmill produced greater increases in overall strength.
2. Pedalling a bicycle, running, and walking on a treadmill produced good gains in physical work capacity as measured by Time on the Treadmill during the Balke treadmill test.
3. Pedalling a bicycle and walking on a treadmill produced moderate gains in cardiorespiratory fitness as measured by $\dot{V}O_2 / \text{kgbw} \cdot \text{min}$. In this experiment there was no significant increase in this variable for subjects who trained by running on an outdoor track.

TABLE IV

MEAN PRE- AND POST-TRAINING VALUES OF
THE MEASURED VARIABLES BY GROUPS

VARIABLE		GROUP			
		A Bicycle	B Running	C Treadmill	D Control
<u>ANTHROPOMETRIC MEASUREMENTS</u>					
Neck (cm)	Pre Post Difference	29.78 30.26 .48	30.58 30.90 .32	31.60 32.08 .48	30.06 30.22 .16
Right Bicep (cm)	Pre Post Difference	26.90 27.06 .16	28.26 28.12 -.14	27.52 27.40 -.12	27.36 27.48 .12
Left Bicep (cm)	Pre Post Difference	26.10 26.06 -.04	27.18 27.38 .20	26.40 26.22 -.18	26.22 26.56 .34
Right Forearm (cm)	Pre Post Difference	23.14 23.10 -.04	24.20 24.14 -.06	23.88 24.00 .12	23.94 24.00 .06
Left Forearm (cm)	Pre Post Difference	22.54 22.38 -.16	23.50 23.42 -.08	23.04 23.14 .10	23.04 23.34 .30
Waist (cm)	Pre Post Difference	65.72 67.32 1.60	69.98 70.88 .90	71.30 71.34 .04	64.82 65.40 .58
Right Thigh (cm)	Pre Post Difference	54.08 54.86 .78	52.86 54.18 1.32	56.30 56.46 .16	53.74 54.20 .46
Left Thigh (cm)	Pre Post Difference	53.62 55.18 1.56	52.34 53.70 1.36	55.66 55.76 .10	53.52 53.98 .46
Right Calf (cm)	Pre Post Difference	35.16 35.70 .54	33.70 34.26 .56	35.20 35.38 .18	34.82 34.70 -.12

TABLE IV...MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS
...CONTINUED

VARIABLE		GROUP			
		A Bicycle	B Running	C Treadmill	D Control
Anthropometric Measurements Continued					
Left Calf (cm)	Pre Post Difference	35.48 35.96 .48	33.34 34.08 .74	35.46 35.80 .34	34.70 34.84 .14
SKINFOLD MEASUREMENTS					
Axilla (mm)	Pre Post Difference	7.66 8.40 .74	10.12 10.96 .84	9.64 11.32 1.68	8.08 7.36 -.72
Tricep (mm)	Pre Post Difference	15.04 14.68 -.36	13.00 13.56 .56	12.32 13.48 1.16	18.40 16.36 -.204
Subscapular (mm)	Pre Post Difference	10.24 10.16 -.08	12.06 12.04 -.02	12.96 13.16 .20	10.88 10.60 -.28
Abdominal (mm)	Pre Post Difference	15.72 14.16 -1.56	15.84 16.08 .24	19.28 19.36 .08	13.76 13.36 -.40
Suprailiac (mm)	Pre Post Difference	9.40 9.00 -.40	10.76 10.84 .08	13.12 14.00 .88	10.20 8.40 -1.80
Thigh (mm)	Pre Post Difference	22.90 25.52 2.62	18.88 21.04 2.16	23.08 23.62 .54	23.44 23.36 -.08
Sum of Six (mm)	Pre Post Difference	80.96 81.92 .96	80.66 84.12 3.46	90.40 94.94 4.54	84.76 81.64 -3.12
STRENGTH MEASUREMENTS					
Shoulder Flexion, Cable (1b)	Pre Post Difference	45.20 52.80 7.60	43.00 52.20 9.20	46.00 53.40 7.40	49.00 51.80 2.80
Hip Flexion, Cable (1b)	Pre Post Difference	84.40 92.00 7.60	75.60 97.00 21.40	83.40 94.80 11.40	92.40 90.60 -.180

TABLE IV...MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS
...CONTINUED

VARIABLE	Pre Post Difference	GROUP			
		A Bicycle	B Running	C Treadmill	D Control
Strength Measurements <u>Continued</u>					
Ankle Plantar Flexion, Cable (1b)	Pre Post Difference	255.80 308.40 52.60	263.80 271.00 7.20	259.60 301.00 41.40	280.20 286.20 6.00
Strength Quotient	Pre Post Difference	.932 1.076 .144	.814 .902 .088	.876 1.018 .142	.960 .968 .008
T Score	Pre Post Difference	52.80 61.60 8.80	53.80 58.40 4.60	54.60 61.40 6.80	59.00 59.40 .40
Elbow Flexion, Cybex (1b)	Pre Post Difference	29.20 25.60 -3.60	30.80 31.80 1.00	26.60 29.40 2.80	28.20 29.20 1.00
Elbow Extension, Cybex (1b)	Pre Post Difference	33.20 34.40 1.20	36.80 43.00 6.20	32.20 36.40 4.20	36.60 39.00 2.40
Knee Flexion, Cybex (1b)	Pre Post Difference	33.60 38.00 4.40	32.80 46.00 13.20	45.00 40.20 -4.80	32.20 42.20 10.00
Knee Extension, Cybex (1b)	Pre Post Difference	44.00 62.20 18.20	61.20 64.00 2.80	49.80 57.40 7.60	62.20 63.80 1.60
Hip Flexion, Cybex (1b)	Pre Post Difference	18.40 21.00 2.60	23.00 22.20 -.80	22.20 15.80 -6.40	24.00 22.40 -1.60
Hip Extension, Cybex (1b)	Pre Post Difference	94.40 117.40 23.00	111.60 112.80 1.20	102.20 93.80 -8.40	86.40 94.40 8.00

TABLE IV...MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS
...CONTINUED

VARIABLE		GROUP			
		A Bicycle	B Running	C Treadmill	D Control
<u>PHYSIOLOGICAL VARIABLES</u>					
One Second Vital Capacity (l)	Pre Post Difference	3.08 3.02 .06	3.30 3.32 .02	3.02 2.90 -.12	3.12 3.12 .00
Maximum Vital Capacity (l)	Pre Post Difference	3.58 3.68 .10	3.66 3.76 .10	3.64 3.52 -.12	3.64 3.58 -.06
Maximum Breathing Capacity (liters/min.)	Pre Post Difference	132.40 135.00 2.60	157.80 163.00 5.20	136.80 136.20 -.60	131.00 142.20 11.20
Respiratory Rate at MBC	Pre Post Difference	119.40 111.60 -.780	137.40 125.60 -11.80	121.80 118.20 -3.60	124.80 107.40 -17.40
Tidal Volume at MBC (l)	Pre Post Difference	1.16 1.20 .04	1.16 1.32 .16	1.14 1.18 .04	1.08 1.30 .22
Body Composition (percent fat)	Pre Post Difference	25.24 24.44 -.80	25.18 24.92 -.26	28.58 28.30 -.28	26.64 26.36 -.28
Weight (kg)	Pre Post Difference	62.68 62.14 -.54	63.06 63.50 .44	66.46 64.62 -1.84	61.26 59.84 -1.42
<u>TREADMILL TEST VARIABLES</u>					
Time on Treadmill to 180 P.R. (min.)	Pre Post Difference	8.40 12.20 3.80	10.40 13.00 2.60	9.80 13.20 3.40	9.20 8.80 -.40
Time on Treadmill to Max. P.R. (min.)	Pre Post Difference	13.20 15.40 2.20	14.40 16.20 1.80	13.00 17.00 4.00	12.00 12.40 .40
Systolic Blood Pressure at Rest (mmHg)	Pre Post Difference	118.00 117.00 -.100	120.00 120.00 .00	126.00 117.00 -9.00	122.00 115.00 -.700

TABLE IV...MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS
...CONTINUED

VARIABLE	Pre Post Difference	GROUP			
		A Bicycle	B Running	C Treadmill	D Control
Treadmill Test Variables Continued					
Systolic Blood Pressure at 180 P.R. (mmHg)	Pre Post Difference	168.00 172.00 4.00	167.00 172.00 5.00	169.00 169.00 .00	155.00 155.00 .00
Systolic Blood Pressure at Max. P.R. (mmHg)	Pre Post Difference	174.00 182.00 8.00	178.00 183.00 5.00	174.00 173.00 -1.00	163.00 161.00 -2.00
Systolic Blood Pressure at 3rd Minute Recovery (mmHg)	Pre Post Difference	138.00 147.00 9.00	148.00 154.00 6.00	137.00 134.00 -3.00	150.00 140.00 -10.00
Diastolic Blood Pressure at Rest (mmHg)	Pre Post Difference	77.00 78.00 1.00	74.00 73.00 -1.00	81.00 78.00 -3.00	80.00 77.00 -3.00
Diastolic Blood Pressure at 180 P.R. (mmHg)	Pre Post Difference	72.00 68.00 -4.00	69.00 72.00 3.00	76.00 65.00 -11.00	73.00 73.00 .00
Diastolic Blood Pressure at Max. P.R. (mmHg)	Pre Post Difference	70.00 66.00 -4.00	68.00 64.00 -4.00	73.00 64.00 -9.00	69.00 71.00 2.00
Diastolic Blood Pressure at 3rd Minute Recovery (mmHg)	Pre Post Difference	80.00 80.00 .00	75.00 77.00 2.00	81.00 81.00 .00	79.00 80.00 1.00
Pulse Rate at Rest (beats/min.)	Pre Post Difference	80.80 82.40 1.60	76.00 79.20 3.20	89.60 80.00 -9.60	80.00 78.40 -1.60
Pulse Rate at 180 P.R. (beats/min.)	Pre Post Difference	180.00 180.00 .00	180.80 180.00 .80	182.40 180.80 -1.60	181.60 180.00 -1.60

TABLE IV...MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS
...CONTINUED

VARIABLE		GROUP			
		A Bicycle	B Running	C Treadmill	D Control
Treadmill Test Variables Continued					
Pulse Rate at Max. P.R. (beats/min.)	Pre Post Difference	199.20 194.40 -4.80	194.40 191.20 -3.20	196.80 192.80 -4.00	199.20 199.20 .00
Pulse Rate at 3rd Minute Recovery (beats/min.)	Pre Post Difference	127.20 114.40 -12.80	121.60 108.80 -12.80	124.80 112.80 -12.00	124.80 118.40 -6.40
\dot{V}_E BTPS at 180 P.R. (1)	Pre Post Difference	53.60 66.00 12.40	64.20 65.40 1.20	71.40 77.20 5.80	62.00 56.40 -5.60
\dot{V}_E BTPS at Max. P.R. (1)	Pre Post Difference	77.60 87.20 9.60	89.60 79.60 -10.00	94.40 93.80 .60	81.20 74.40 -6.80
\dot{V}_E STPD at 180 P.R. (1)	Pre Post Difference	44.80 55.40 10.60	53.20 54.40 1.20	59.20 64.20 5.00	51.60 47.20 -4.40
\dot{V}_E STPD at Max. P.R. (1)	Pre Post Difference	64.80 73.20 8.40	74.00 66.20 -7.80	77.80 78.40 .60	67.60 62.20 -5.40
Respiratory Rate at 180 P.R. (breaths/min.)	Pre Post Difference	27.40 34.00 6.60	29.80 30.40 .60	40.20 37.00 -3.20	31.20 31.20 .00
Respiratory Rate at Max. P.R. (breaths/min.)	Pre Post Difference	38.80 41.00 2.20	43.80 35.60 -8.20	47.00 44.40 -2.60	40.60 38.00 -2.60
Tidal Volume at 180 P.R. (1)	Pre Post Difference	1.96 1.94 -.02	2.16 2.16 .00	1.84 2.14 .30	2.02 1.88 -.14

TABLE IV...MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS
...CONTINUED

VARIABLE		GROUP			
		A Bicycle	B Running	C Treadmill	D Control
Treadmill Test Variables Continued					
Tidal Volume at Max. P.R. (l)	Pre Post Difference	2.02 2.14 .12	2.08 2.26 .18	2.06 2.24 .18	2.04 2.00 -.04
. \dot{V}_{O_2} at 180 P.R. (l)	Pre Post Difference	1.740 1.998 .258	1.866 1.928 .062	1.900 2.186 .286	1.694 1.630 -.064
\dot{V}_{O_2} at Max. P.R. (l)	Pre Post Difference	2.194 2.274 .080	2.244 2.166 -.078	2.254 2.404 .150	2.140 2.038 -.102
\dot{V}_{O_2} /Pulse at 180 P.R. (ml)	Pre Post Difference	9.68 11.12 1.44	10.34 10.72 .38	10.42 12.10 1.68	9.32 9.06 -.26
\dot{V}_{O_2} /Pulse at Max. P.R. (ml)	Pre Post Difference	10.98 11.70 .72	11.56 11.32 -.24	11.44 12.42 .98	10.74 10.24 -.50
\dot{V}_{O_2} /kgbw·min. at 180 P.R. (ml)	Pre Post Difference	27.56 31.50 3.94	29.44 30.52 1.08	28.70 32.92 4.22	27.72 26.98 -.74
\dot{V}_{O_2} /kgbw·min. at Max. P.R. (ml)	Pre Post Difference	34.68 35.86 1.18	35.60 34.56 -1.04	33.98 36.36 2.38	34.96 33.86 -1.10
\dot{V}_E/\dot{V}_{O_2} at 180 P.R. (l)	Pre Post Difference	30.90 33.12 2.22	34.76 33.88 -.88	37.92 35.36 -2.56	36.70 34.62 -2.08
\dot{V}_E/\dot{V}_{O_2} at Max. P.R. (l)	Pre Post Difference	35.72 38.56 2.84	39.64 36.52 -3.12	42.06 39.28 -2.78	38.74 37.08 -1.66

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